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ART. I.—*Anatomy of the Bullet-track, and Cicatrices of the Wounds of Entrance and Exit.* By MIDDLETON MICHEL, M. D., Professor of Physiology and Histology, in the Medical College of the State of South Carolina, Charleston.

Contradictory assertions respecting certain points in the history of gun-shot wounds, having presented themselves at the time when our minds throughout this country were wholly engrossed with the study of this class of injuries, it occurred to me to make personal observations upon the aspect of the bullet-track, and the characteristics of the cicatrices of the wounds of entrance and exit. The results of these inquiries were recorded and reported to the Association of Army Surgeons convened in Richmond, Va., and I give further publicity to them now in the belief that whatever interest they seemed then to attract, will again be excited among those who are concerned in such discussions.

Inspection of the entire extent of the bullet-track will not be considered of no practical import, if it give a proper conception of the nature of the injury inflicted; of the exaggerated reports of the ravages of the minie-ball; of the mode in which reparation may occur; and of the imperative demands of conservative, as opposed to demolitionary Surgery in very many instances. A critical examination of these cardinal points in the history of gun-shot wounds, aided by a series of anatomical dissections, engaged many of my leisure moments, when surrounding circumstances furnished rare facilities for such studies, and access could be had to no source of information more certain than direct empirical research.

The first misconception of a gun-shot wound which my dissections appeared to rectify, was the oft-repeated assertion that the bullet tunnelled a conical passage through the tissues, the apex of which corresponded to the orifice of entrance, and the base to

that of exit; an opinion predicated of gun-shot injuries because the former of these wounds is usually the smaller of the two.

Ever since Percy first pronounced the conical shape of the bullet-track, this opinion has been reiterated in almost every systematic treatise on Surgery, and sustained by the rehearsal of the well known plank-experiments of Dupuytren, Hugier, and others.

The bullet, in its transit through a resistant medium of uniform density and structure, as presented by the superposition of several planks of wood, exercises doubtless an increasingly destructive influence from the nature of the resistance encountered in its movement of translation and gyration, and this must and does produce a progressively enlarged pathway through the boards; but the conditions are different when its flight takes place through structures, the variable contexture of which differs in every conceivable degree of resistance, from the delicate net work of connective tissue to the solid one of bone. In such a transit through living structures, the missile advances not only through media of different densities, but through parts in different states of contraction or relaxation, tension, activity, or repose; conditions calculated to facilitate or impede, direct, guide, or deflect it in various ways.

There is, indeed, nothing more conspicuous, on laying open the entire track of a gun-shot wound, than the combined influences of all these agencies, not alone upon the route the ball is made to take, but upon the nature of the damage it has inflicted. The slightest resistance deflecting the missile when at its maximum velocity, drives it entirely through one tissue, around another, and perhaps between a third, so that we find it crushing the one, lacerating the other, and simply separating almost without the slightest injury organs loosely held together. The varied relations which thus always ensue among the unequally divided and injured tissues, and which is appreciatively studied only by an anatomical dissection, is again advisedly recognized in the digital exploration of the wound, when the now educated finger penetrates into no gradually increasing infundibular wound, but, on the contrary, encounters portions of pulpified tissue, shreds of lacerated structures projecting across and so far into the track as to convey the sensation experienced when we meet the placenta in a vaginal examination; and this peculiar choking of the shot-track is yet more readily verified when the examination is made through the exit orifice, for then we may detect the general drift of all the detritus towards this opening. Nor is this a simple occlusion of the track by disintegrated fabrics, for dissection exhibits parts of this track in actual contact, with nothing intervening, not even clots of blood, with little or no apparent damage, not a vessel or nerve implicated, perhaps the bone itself untouched, nothing to justify the supposition that this

part of the injury belonged to the class of lacerated or contused wounds, nothing to prevent the sides of the wound from coming into speedy union, as they already lie in easy apposition ; while just before or beyond this particular spot, the charred and disorganized tissues give a gangrenous appearance to the rest of the wound. Now, such a wound is far from disclosing the funnel shape usually ascribed to gun-shot injuries. Opened by the scalpel in its entire extent, at the point of entrance there almost always is loss of substance, the integument is punched out, for the piece has been actually discovered lodged in the deeper parts of the wound, though of this I myself cannot speak, having never had the luck to meet it ; the cellular tissue is lacerated or channeled to some extent, which is well seen when the part is dissected under water, and which prepares a substratum or bed for extension of inflammation and diffusion of pus ; aponeurotic expansions are simply split, as is also the integument itself, when this is stretched over a part either from position or the rigid contraction of the muscles beneath, both of which require often to be sacrificed even to admit the finger freely ; the muscles present all degrees of injury, being sometimes only contused, sometimes actually dissected from one another, though still in absolute contact, while others may be lacerated into shreds hanging in every direction about the track, irrecoverably disorganized in one part, or in apposition in another; so that the bullet wound may be said to be more modified in its appearance by the injured muscles than by any of the other tissues, for tendons slide about intact in their synovial investments, and prominent vessels and nerves comporting themselves in like manner in their sheaths often escape through a mysterious, though provident, arrangement not readily explained. Mutilations of this nature, thus analyzed by the scalpel, reveal different conditions in different parts of their extent ; in one part, and that not always where we might have expected, is perhaps a breach which the processes of repair must restore, or supply by the fibroid exudates of some future permanent cicatrix ; at another a gap may exist, where divided muscular fibres have retracted, leaving spaces never bridged across by elements of the lost tissue, though united ultimately by ligamentous formations ; elsewhere disorganized fabrics are hanging loose in the track, which soon must slough, disintegrated parts everywhere are met which must be elimated, and abraded surfaces that sooner or later will ulcerate ; whilst the least injured and resilient structures, but little displaced or disturbed, remain in apposition so as first to cohere and then unite. Again, a dense aponeurosis will often occlude the track or only indicate the passage by rent, while spiculæ of bone and masses of lacerated tissues fall in and fill up the rest of the passage. The walls of such a wound are, therefore, more or less separated in parts of their extent, and in absolute contact

in others, readily uniting here, while undergoing elsewhere most active repair. In presence of this ascertained condition of a gun-shot wound it is needless then further to refute the opinion which ascribes to these injuries a conical shape.

Another point which these dissections elucidated, was the actual amount of injury bone sustained.

The writings of those fitted to instruct us on the special effects of the minie ball, had certainly impressed one fact upon the minds of the inexperienced, and this was the magnitude of the cleavage and fracture of bone : while they dwelt particularly upon the longitudinal splintering of long bones, graphically described as extending along the entire axis of the shaft into the very joint itself; so that if one fact more than another was enforced, it was the havock produced by the minie ball upon osseous tissue, which could in no wise be supposed to escape the mechanical influences of a wedge-shaped missile, that insinuates itself on well known principles, to realize always every result attendant upon such conditions.

American experience to a certain degree confirmed the general verdict of European writers on this point, for the greater effect of the conical as contrasted with the round ball was repeatedly verified in the large fragments of bone which the finger discovered dislocated and frequently drifted towards the exit orifice; and in several specimens, at one time in my possession, I was equally certain of the extensive splitting of the shafts of bones, in which the ball lodged so firmly, that it was not easily displaced in preparations that had long macerated. Under these teachings, and with these examples of mangled bones before me, I was not prepared to find so little actual injury of this particular tissue, as the oft-repeated dissections of limbs revealed, which had been amputated under every contingent circumstance, especially when the operation was indicated from the very considerable nature of the injury. In these examinations, though always meeting with osseous spiculæ of some size, either lying in axial relation with the shaft, or if dislocated still adhering through periosteal attachments, yet it frequently happened that but one such fragment existed, being the very piece which the finger reached while exploring the wound ; and it just as often happened when some complication, such as rupture of vessels or nerves, or prolonged suppuration made amputation necessary, that the bone was simply fractured transversely, and so little damaged as of itself not to have justified the operation. In very few instances which I now recall was the shaft splintered to any considerable distance from the seat of the wound. I feel very confident, therefore, that the majority of surgeons of field and hospital experience will sustain me in the statement, that whatever may have been our theoretical opinions on this subject, the idea of a splintered bone, splintered through the greater part of

its length, seldom if ever modified the operative procedure, or prevented its perfect and safe fulfillment at the point of election. I am equally sure that this kind of simple fracture was far more common than is even now generally supposed by those who with some experience in such matters, fall back in memory rather to the authorities they then consulted, than to the clinical lessons long since forgotten. It will be remembered also that resections were constantly performed, which were seldom rendered impracticable from any such complication as the one referred to.

I am led to reflect also upon a somewhat significant fact, that in almost all the above mentioned specimens in which this particular kind of splitting occurred, the ball had lodged. It is not probable that this destructive effect takes place when the missile is possessed of its maximum velocity, and though very apt to occur when it is nearly spent, this is an exceptional condition not always met with. With regard, therefore, to the effects of the minie ball on long bones, I must maintain that the axial cleavage of the body of the bone is the exception and not the rule ; that it does not often exist to modify the operations which are performed, whether these be amputations or resections ; and that it is met with only perhaps when the ball is spent and has become lodged.

From the above observations, I am of the opinion that the destructive effects of the minie ball are in direct ratio to its *diminished* velocity plus its weight, and though not competent to decide this point upon physical principles, yet it appears to me that at its maximum velocity it cuts its way through all the tissues with less damage relatively than is generally supposed; and I was led to imagine that under rare combinations of contingent circumstances not possible to comprehend exactly, it might inflict not more injury than the round ball, and the following cases, with such reflections as accompany them, prove that I was not mistaken. Such circumstances might be supposed to exist as would permit the transit of a conical ball through the several planes of the different surfaces and fibres of all the structures, as simply to separate or divide, rather than contuse or lacerate them, although they would be coincidences so remarkable in themselves as appear to render such an occurrence improbable. The very announcement that a gun-shot wound, which we know must suppurate, should fall into apposition throughout its continuity, pour out plastic lymph spontaneously assuming organization, and re-establish union, appeared to subvert the best ascertained and most reliable dogmas in the science of surgery. That small size round shot or ball should produce no greater disturbance than the puncture of some sharp instrument, is a matter of no wonder, all the old writers furnish such instances, and modern authorities, Larrey, Sanson, Vidal de Cassis, have seen the joints transfixed and absolutely opened, yet pro-

gress rapidly and with little inconvenience to a perfect cure; but that the conical ball should comport itself ever in this way, we thought worthy of special inquiry, for which reasons I interrogated the army surgeons as to their experience, which was so significant that it permitted me to state that a wound inflicted by a minie may and does present the phenomenon of spontaneous cure; that is, without suppurating, exhaling only from its surface that amount of formative product interposed to bring the surfaces into more speedy union. We record the following cases as of great interest:

Case 1.—Surgeon A. M. Fauntleroy, Medical Director of the Department of North Carolina, communicated to me the case of a private of the 8th Louisiana Regiment, who was shot by the accidental discharge of a companion's gun—rifle, minie. The ball entered the inside of the left foot, coursing the arch of the instep, coming out at a point opposite its entrance. Suppuration never occurred, and the wound healed by first intention.

Case 2.—At the battle of Drainsville, Surgeon E. S. Gaillard had under his care a private whose gastrocnemius muscle was perforated by a minie ball, yet this party recovered without suppuration.

Case 3.—Surgeon W. S. Mitchell, Chief Surgeon of Rhodes' Division, informed me that Lieutenant E., of the 12th Georgia Regiment, was wounded by a minie ball, which entered about half an inch above the dorsum of the penis, to the right of the middle line, making its exit on the outer and posterior portion of the right buttock. There was no suppuration. The Lieutenant was never confined to bed, and the orifice of exit was entirely closed by the third day. The orifice of entrance almost immediately scabbed over, and was healed in eight days.

Case 4.—Surgeon J. B. Read gave me the case of Lieutenant N. R., of the 10th Virginia Cavalry, wounded June 20th, 1863, at the battle of Brandy Station: a minie ball entered the sixth intercostal space on the right side, making its exit at the fourth intercostal space of the same side, three-quarters of an inch externally to the nipple; expectoration of blood and escape of air were observed, but all of this disappeared by the 30th June, no suppuration occurred, no scabs existed on either wound, and auscultation revealed a perfectly healthy lung.

There seems some common features of resemblance between these first four cases, as perhaps indicating the conditions most favorable to such results, these are: The superficial nature of the injuries, the obliquity and perhaps valvular character of the wounds, and the short range of fire, at least in two of the cases, the ball entering very soon after its discharge from the piece, with its initial velocity, which we know is the maximum velocity of a ball. In one instance, the missile follows the convexity of the instep; in the second case, notwithstanding the diversity

of sentiment as to its passage through the abdomen, there is little doubt of its having coursed along the walls of that cavity; and in the chest wound, as sometimes happens, the ball passed perhaps between the lung and the walls of the thorax without seriously wounding the pleura, and certainly not the lung, since careful auscultation disclosed not the slightest impairment of the functions of that organ, for it will not be argued that the expectoration of blood, or even escape of air, are indications to the contrary, since these phenomena are not unequivocal evidences of lesion of this organ.

But what is far more remarkable in this connection, we have still to record an equally favorable termination, where more serious injury existed, involving deeper seated organs and complicated with fracture.

Case 5.—Assistant Surgeon McQueen, of Daniel's Brigade, reports that after the battle of Chancellorsville, among the wounded remaining in his charge at the "Lacey" house, was a man with compound comminuted fracture of upper third of femur, wound from a minie ball, which healed in less than a week, without suppuration.

Case 6.—Professor Henry Fraser Campbell furnishes me the history of Lieutenant-Colonel ———, wounded through both thighs. The left thigh was fractured; the right was a simple flesh wound; while the former underwent the reparation incident upon such an accident, suppurating abundantly, the flesh wound, though a deep one, healed promptly without any discharge, the patient himself manifesting some concern at the circumstance, under the impression, very common among the inexperienced, that his wound could not be doing well, since it did not discharge pus like the other.

The following cases are still more remarkable as exhibiting the autocracy of nature even in the presence of the gravest accidents of battle.

Case 7.—Surgeon J. B. Read reports that Lieut. S——, of the 3d Georgia Regiment, wounded at Manassas Gap by a minie ball, above both knees, which lodged on external side of right knee, while in the act of stepping forward. He lay four weeks without surgical treatment with one thigh fractured, and after sixty miles transportation in a wagon, reached the railroad that brought him to Richmond. His wounds were then covered with dry scabs, and being a physician himself, he gives the assurance that there had been no suppuration, that at the expiration of four weeks he had used crutches. There was consolidation, with one and a quarter inch of shortening on the right side.

Case 8.—Surgeon C. J. Clarke, of the Alabama Hospital, furnished the history of Jonathan Sykes, of the 13th Alabama Regiment, at the battle of Chancellorsville, May 3d, 1863, was wounded through upper-third of the thigh, ball entering six

inches below the anterior-superior spinous process of the ilium. He entered the hospital the 23d May. Neither the ball nor any fragments of bone had been removed; there had been no purulent discharge from the wound. The wound, at the time of his arrival was completely healed; his limb was, however, placed on a double-inclined plane, with suspensory slings; no suppuration occurred during his stay in the hospital. He made a good recovery, with a limb shortened two inches.

The above cases, supported by all the evidence necessary fully to substantiate them, and their possible importance in a medico-legal aspect, will authorize a particular review of the principles of pathology upon which they most likely depend.

The great danger dependent upon a compound comminuted fracture, accompanied by all the commotion or destruction of the soft parts which may be conceived to exist, is inflammation and its products; and experience teaches that the introduction of air into such a wound is above all other causes that most fraught with pernicious consequences; for it is such an accident that inevitably gives rise to high inflammatory action, and this, in its turn, to the production of pus, which interrupts, suspends, and inevitably postpones reunion. A more or less prompt healing by first intention under similar breaches of continuity, when the subjacent integuments are uninjured, is of daily occurrence; and a comminuted fracture, with loss of substance and such displacement of its fragments as to produce considerable shortening of a limb, with laceration of the soft parts, injury of the periosteum, destruction of the muscles, their sheaths and surrounding cellular tissue will often be repaired without development of suppuration, if the introduction of air has been prevented. The extravasation of blood and exudates of a viscid and gelatinous consistency are very soon transformed into the provisional and definitive callus and cellulo-fibroid structures, which bridge the entire track of the injury, without evolution of the morbid products of inflammation. Therefore, it may be possible in certain exceptional and very rare conditions of a gun-shot wound, in which the orifices from their obliquity or valvular state perfectly exclude the ingress of air, that it should find itself placed in no dissimilar condition from an ordinary comminuted fracture. The possibility of such an event is certainly exhibited in the illustrations above noted, while the extreme rarity of the occurrence is equally shown by the very few cases we have been able to obtain. From the relations in which we have sometimes found the walls of the bullet-track in certain portions of their extent—that of nearly complete apposition, and in a short time of partial coherence—we must refer these examples of immediate adhesion to accidental coincidences in the special direction taken by the missile through the organs of the body, consorted fortunately with its maximum velocity. To

these physical conditions, so naturally and obviously interdicting the entrance of air, rather than to any peculiar constitutional healthiness on the part of the subject, would I refer so unexpected and favorable an issue. We may, therefore, say that, long as the contrary opinion has been entertained, it is now beyond doubt that even deep-seated lesions of the character we have been examining, do occasionally heal by first intention, little or nothing more exuding from the orifices of entrance and exit but a viscid, gelatinous, turbid and oleoserous fluid of a yellowish red or brownish color which incrustates and promptly closes them.

This spontaneous mode of healing is far more frequent when the injury assumes the appearance of an incised wound. I have seen and recorded instances of this kind, especially where such linear wounds existed about the head and face. Some of these cases came under my observation on the battle fields of the Wilderness and Spotsylvania. (Confederate States Medical and Surgical Journal, vol. 1, p. 101).

The practical teachings of such experience as this paper records, press the claims of conservative surgery upon us, and make us deliberately consider the many chances a mangled limb possesses through the inherent reparative resources of nature; a truism of enlightened surgery which we would not endeavor to enforce had we not witnessed the wholesale demolitionary practice that sacrificed limbs on many occasions, through the bullet-tracks of which when laid open, some simple fracture with moderate laceration of the soft parts, without a blood vessel or nerve of any importance being involved, was all that we could discover, and whose preservation ultimately might have been a matter of time only, if consorted intelligently with patience and care.

We now turn to another division of our subject.

The cicatrices of these wounds bear attestation of the mode of repair the latter have undergone, and their history forms a topic of consideration to the pathologist, and of significant import to the medical jurist in determining their relations to the orifices of entrance and exit, and consequently to the probable position of the assailant and the direction of his fire.

To furnish a correct account of the cicatrices of gun-shot wounds, some details of the healing process are necessary, for when these wounds heal spontaneously, as above described, no very determinate traces are found to remain, but when they have gone through the ordinary stages of repair, after having suppurated for some time, remarkable evidences remain forever of lesions so severe, and the consequent cicatrices of such wounds exhibit a sort of epitome of their history which we may, I think, read in the differences that exist in the size, shape, and actual condition or anatomy of the cicatrix.

We are all familiar with the general history of these openings. The orifice of entrance is often smaller than that of exit, of a more or less regularly defined circular shape, surrounded by an ecchymotic areola, inverted edges and aperture patent, perhaps emitting a sulphurous odor, but discharging little blood. The exit orifice is the larger, of irregular shape, edges lacerated and everted, and shredded textures drifting through the aperture which is discharging a sero-sanguinolent fluid. These features are the more distinguishable the earlier the wounds are inspected, for the subsequent changes through inflammation result in tumefaction, eversion, and suppuration at these apertures, which render it impossible to decide with accuracy. But it is questionable whether these characters are so associated as often to render the determination positive even at an early period. It is certain that no one of these conditions will of itself adjudge the case, while it may be shown that all combined have in a majority of instances failed. It was remarked throughout the army that uniformity in size of bullet wounds was often very striking, and we have observed an alternate predominance in favor of each of these openings in point of size; Surgeon V. D. Hill had two cases in his hospital (Quintard, Georgia), in which the orifice of entrance was twice the size of that of exit. Inversion, so insisted upon as pertaining to the entrance wound, is even in recent injuries much less frequent than is supposed. Hemorrhage occurring from a deep and devious wound together with coagula, was observed by my friend Surgeon Lane, of the Winder Hospital, to have actually everted the borders of such an opening, especially when the integument had lost its elasticity in consequence of the attendant contusion; an observation it would be well to corroborate in instances in which some large vessel has been wounded and hemorrhage has continued for a time with force.

The circularity of this opening varies often in assuming a valvular, oblong, or irregular shape, sometimes again even closely resembling an incision from its linear character; and the very same variations exist with respect to the orifice of exit. If one condition more than another can be depended upon in discriminating between these openings, I take this to be the peculiar sensation which the finger experiences while exploring these orifices, the freedom with which it moves in the one, and what I would term the *placental sensation* imparted to it at the other.

Our field Surgeons expressed more confidence in the characteristics of these openings, and in their ability to recognize them, than did our hospital Surgeons, who, it appeared to me, with singular unanimity, placed very little reliance upon such differential characters as a rule; a circumstance which certainly shows what changes must ensue in these wounds somewhat rapidly,

since the disabled on the field are soon transferred to the nearest hospitals.

But it is interesting to discover that if reactionary processes disturb such primary features as may at first be determined upon, when these vital operations have accomplished their end, and all is quiet along the bullet-track once more, we can in the anatomy of the cicatrices again perhaps decipher the history of an injury, in many of its particulars, which these marks indefectibly perpetuate.

The mode in which these apertures heal involves a history of the entire process of reparation, upon which we have no intention to enter ; but it is not sufficient to say that these wounds suppurate; the restorative process, if analysed, gives the history of the cicatrix, and *vice versa;* therefore we must remember that parts divided and in apposition enter soon into union, while bruised and disintegrated portions join in the suppurative drain, and this discharge may occur from both orifices, though the one through which the most protracted drainage ensues exhibits that portion of the track that has most suffered laceration, contusion, and disorganization. From the irregular state of such a track it is impossible to say precisely where the process of repair will first be accomplished; but this much we know, that that division of the track, along which this histolytic action has continued longest, will eventually through the extensive loss of substance it sustains, present the greatest coaretation and puckering of its surface orifice. Such, indeed, is the true philosophy of the suppurative act, which is not to be ascribed to some mysterious pyogenic spot pouring out pus, which gravitates towards the most dependent opening, for a wound which heals first at some central portion of its track will suppurate from both orifices for a time, and then the most dependent opening may heal, while from some abnormal deviation in the reparative process the other orifice, which may be at the upper or anterior portion, will continue to eliminate pus until some foreign body is discharged, or some ulcerative action ceases. I have often witnessed the healing of a most dependent wound, while nothing could account apparently for the protracted delay at the upper orifice, which continued to furnish an undiminished supply of pus, which coursed against gravity. The healing of these orifices do not depend upon position or pressure upon the part, but rather upon the fact that the simply lacerated wound of exit, in a majority of cases corresponds to some one point upon the posterior aspect of the injury. Under varied circumstances modifying the conditions of these openings, different results in this respect must and do occur. It is obvious that where foreign bodies and osseous fragments are making their escape, unless speedily removed, the efforts of nature are interrupted in that direction ; and it is

equally apparent that should a ball in its comparatively harmless transit through fleshy parts finally open a joint in its exit, that the latter wound at once assumes a degree of importance well calculated to raise apprehension, as it will be found to defeat all ordinary resources in the way of treatment. In ordinary uncomplicated cases the exit orifice is found to heal first, that of entrance suppurating sometime after the perfect occlusion of the former. Surgeon J. G. Brodnax, of the North Carolina Hospital, in Petersburg, Va., furnished me fifty three cases, in which the orifice of exit healed first in thirty-five, and that of entrance in eighteen; the more dependent wound healed first in thirty, the higher in fifteen, and the eight remaining cases presented horizontal wounds healing almost together. Of ninety cases which we have registered, I find that the exit wound closed first in fifty-five instances. These statistics, as far as they go, show that the orifice of exit and the one which is most dependent generally healed first. In this way we may account for the frequency with which, during decumbency, the posterior wound cicatrices notwithstanding the gravitation of pus.

It is not without interest that we become notified of the mode in which these apertures are healed, since, as I have said, their cicatrices furnish a *résumé* of the pathological process through which they have passed. It may not be impossible, therefore, to determine, sometimes years after an accident of the kind, in which direction the missile passed by inspection of these cicatrices.

In this connection we called the attention of the Association at one of its meetings to some fifty cases selected at random in several of the hospitals in Richmond, in which, with some exceptions, we were able to recognize certain differences. Gentle pressure over one of the cicatrices will sometimes discover the loss of substance not only of the elastic derm or true skin, but of the subjacent tissue also, in the doughy or spongy sensation which the finger perceives ; the integument seems loosely adherent at this point, is easily raised when pinched up into a fold, and the moulding processes of cicatrization leave a somewhat defined circular mark. The contrast at the opposite cicatrix is striking. Here the irregular, stellated, puckered, and adherent fold of skin gives to the traces of former injury at this point an umbilicated appearance. These were the predominant characteristics of these wounds from my personal observations, and they are confirmed by the Surgeons who kindly assisted me. Surgeon J. Chambliss, of the 2d Division, Winder Hospital, aided in tabulating some eighteen cases under his immediate charge, which I here introduce :

Table of Relative Difference in Appearance and Size of Entrance and Exit of Ball.

ENTRANCE.	No.	EXIT.	No.
Indurated	11	Indurated	5
Elevated	12	Elevated	1
Umbilicated	1	Umbilicated	13
Loose Attachment, or non-Adherent	17	Loose Attachment, or non-Adherent.	1
Adherent	1	Adherent	17

No. Class.	ENTRANCE.			EXIT.		
	CIRCULAR.	OBLONG.		CIRCULAR.	OBLONG.	
	DIAMETER.	LENGTH.	WIDTH.	DIAMETER.	LENGTH.	WIDTH.
1	½ inch			¾ inch		
2	½ inch				¾ inch	½ inch.
3		¾ inch	½ inch.		1 inch	½ inch.
4	½ inch			1 inch		
5	½ inch			½ inch		
6		1 inch	½ inch.		1 inch	¼ inch.
7	½ inch				½ inch	¾ inch.
8	¾ inch			¾ inch		
9		1 inch	½ inch.		1 inch	½ inch.
10	½ inch			1 inch		
11		½ inch	¼ inch.		½ inch	¼ inch.
12	½ inch				1 inch	½ inch.
13	¼ inch			1 inch		
14		½ inch	¼ inch.		½ inch	¼ inch.
15	¾ inch			½ inch		
16	½ inch				½ inch	¼ inch.
17	1 inch			¾ inch		
18		¾ inch	½ inch.		1 inch	¾ inch.

SUMMARY.

Entrance, largest	3	Entrance and Exit same	4
Exit, largest	11		

It will be observed from the summary of this table that certain points of distinctive interest occur. First, at the wound of entrance, the cicatrix is more indurated and elevated than at the wound of exit. The wound of exit is more frequently umbilicated in the proportion of 13 to 1, than the wound of entrance. Again, the cicatrix of entrance is more frequently non-adherent to subjacent parts in the proportion of 17 to 1 than the wound of exit. It is also worthy of note that the subcutaneous wound can be plainly felt beneath the cicatrix of entrance from its loose attachment, whereas it is quite indistinct, if discernible at all, at the exit wound in consequence of the close attachment to subjacent tissue. I am inclined to believe that in a majority of cases of wounds unattended with extensive fracture of bone, or in their cure uninterrupted by hospital gangrene, erysipelas, or sloughing—healing from the first kindly—we can see decided landmarks of difference in these cicatrices. In other words, to examine a fresh bullet-hole and to examine the same when healed, the relative appearance of each is reversed: thus, the entrance from being inverted, when cicatrized is elevated or somewhat everted, while the exit originally everted, becomes puckered, inverted, or umbilicated. A fair test of this investigation cannot be obtained from cases which have suffered in their cure

from hospital gangrene, erysipelas, &c., as such diseases, by destroying more or less extensively the soft parts, change entirely the character of the wound ; neither can we have fair examples from cases in which there has been extensive fracture of bone, as the throwing off of spiculæ or the existence of necrosis tends to produce umbilication. I would also remark that when cicatrices are examined, the patient should stand or place the limb in such a position as will bring the muscles into action, or place them on a stretch, to show the attachment of the cicatrices to subjacent parts; the limb should also be placed in a position as near as possible to that in which it was held at the time of the reception of the wound.

A résumé of my researches as contained in this paper furnishes the following conclusions:

1st. The bullet-track is not a conical wound.

2d. From the irregularity of the shot-track, parts of its walls are in contact, which soon adhere and heal, while suppuration elsewhere may continue for a time from both openings.

3d. In exceptional instances, the wound from a conical ball accompanied by fractured bone and shortening of limb, heals spontaneously without suppuration.

4th. The demolitionary effects of the minie ball on osseous tissue has been exaggerated, since the axial cleavage of the shafts of long bones was not so frequently encountered as has been generally stated.

5th. Misconception of the ravages of the conoidal ball led to unnecessary sacrifice of limbs.

6th. Differential features of entrance and exit wounds, if reliable, are the more readily seen the earlier these are examined.

7th. The cicatrices will often again indicate the separate orifices.